



ColorSync and Digital Media

Session 509





ColorSync and Digital Media

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ColorSync and Digital Media

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ColorSync Engineers

ColorSync and Digital Media

- Overview of ColorSync
- A ColorSync Chain
- ColorSync Jaguar Update
- ColorSync and Quartz
- ColorSync for Video
- Q&A





Overview of ColorSync

Overview of ColorSync

- Problem: Devices represent color in different spaces and different gamuts
- Solution: ColorSync is a complete color management system, designed to provide consistent color across devices
 - ColorSync can also be used to produce special color effects



Overview of ColorSync

- Open system based on:
 - ICC Profiles
 - Color Management Modules-CMMs



Overview of ColorSync

- ICC Profiles
 - Cross-platform file format defined by the International Color Consortium
www.color.org
 - Describe how to transform colors between device color space and interchange space
 - Classes: Input, Display, Output, Abstract, Named . . .
 - Spec encompasses standard color spaces such as sRGB and NTSC

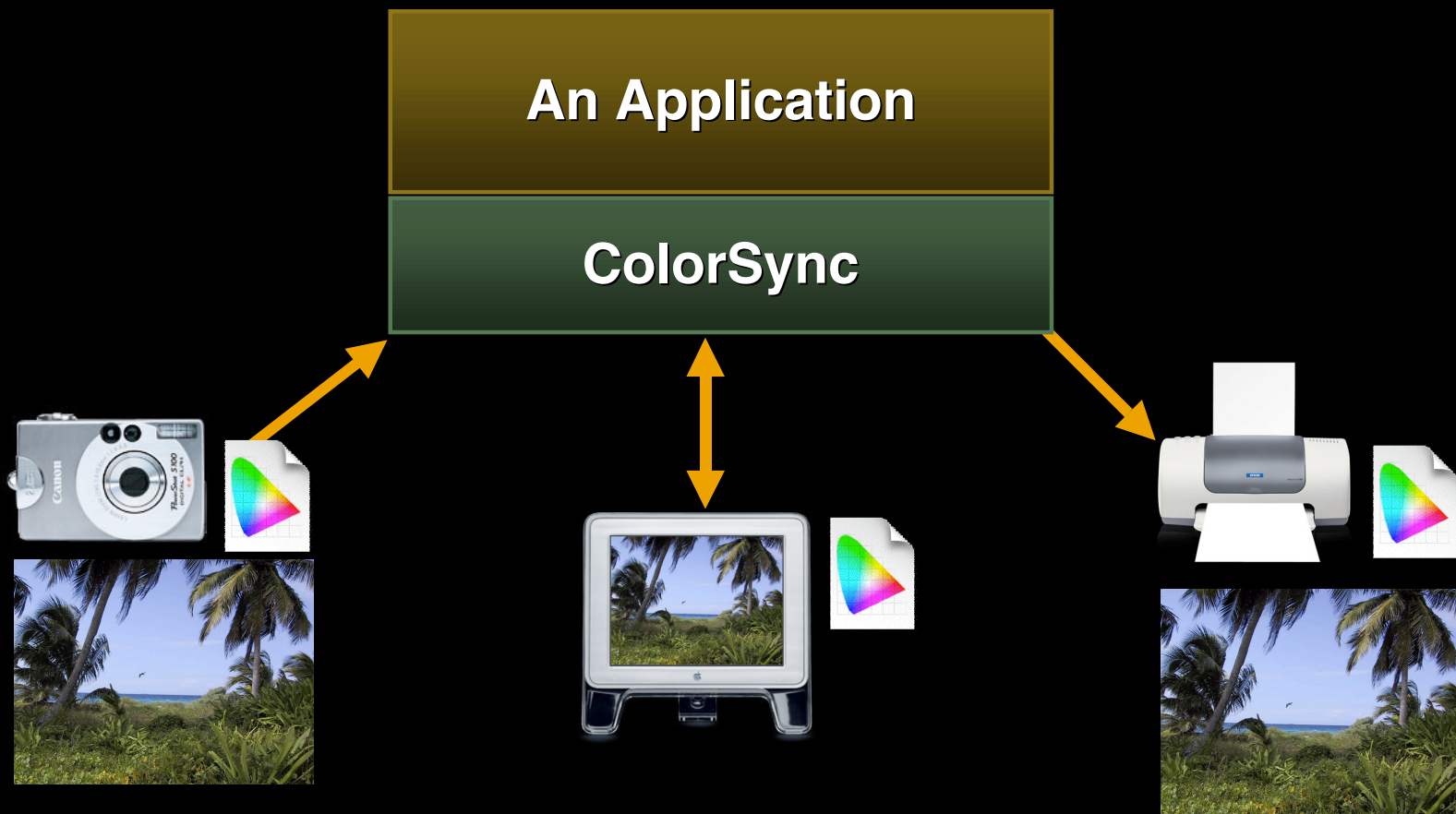


Overview of ColorSync

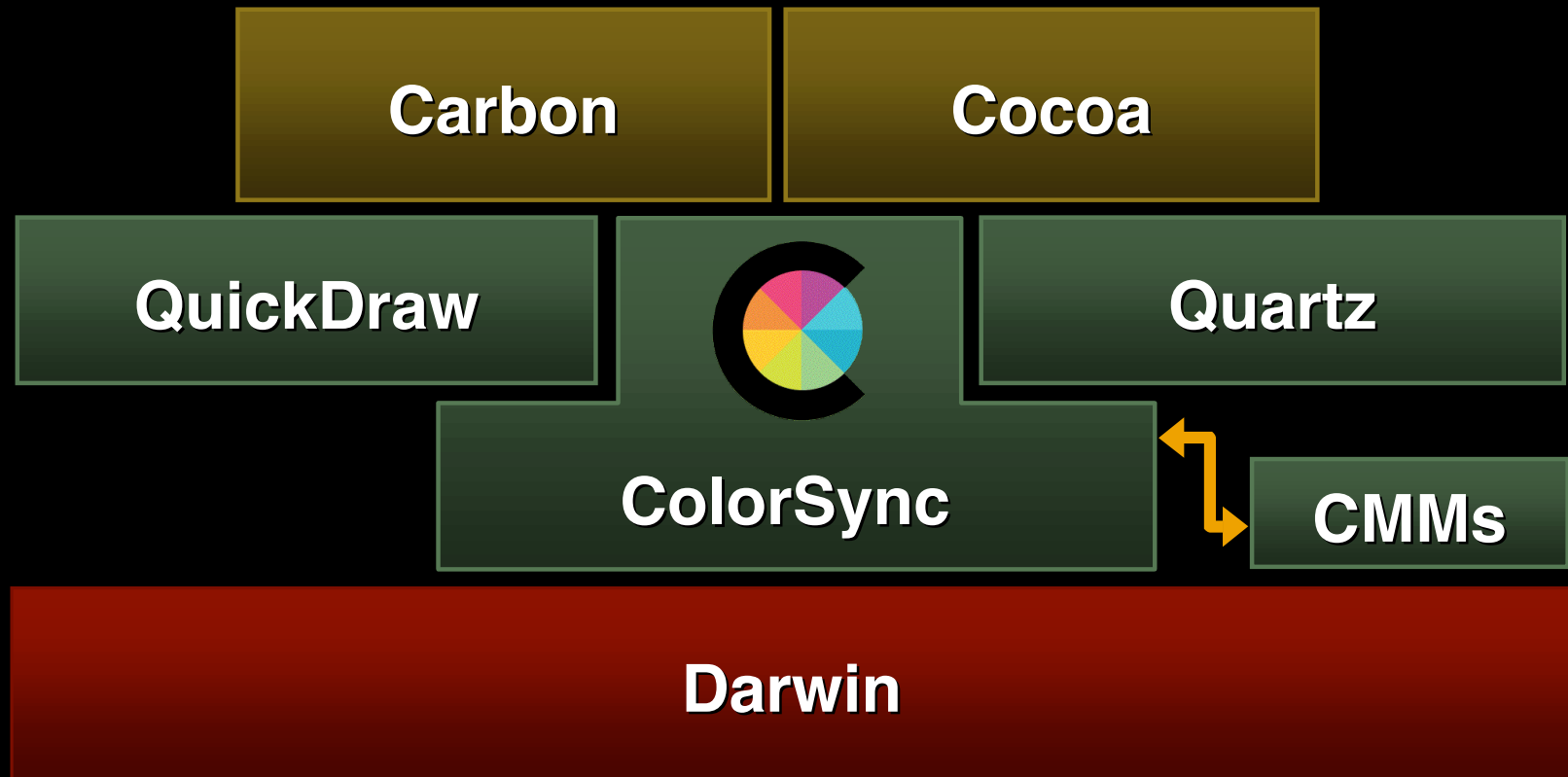
- Color Management Modules—CMMs
 - Provide the mathematical engine to perform profile transformations
 - Apple is default CMM
 - Open system, third-party CMMs available from Kodak, Heidelberg, etc.



Overview of ColorSync



Overview of ColorSync



Overview of ColorSync

- Key pieces of ColorSync
 - UI: Preference Pane and ColorSync Utility
 - API: Framework
 - Profile access API
 - Profile search and iteration API
 - Device Integration API
 - ColorWorld API
 - CMM
 - Profiles



A ColorSync Chain

- Acquired by Image Capture Arch
- Edited in a Carbon App
- Converted by a QuickTime tool
- Printed from Preview
 - Rasterized by Quartz
 - Through a printer driver
 - To an ink-jet printer



A ColorSync Chain—Weak Links

- Acquired by Image Capture Arch
 - **Few cameras register profiles**
- Edited in a Carbon App
- Converted by a QuickTime tool
 - **Apps must check for embedded profiles**
- Printed from Preview
 - Rasterized by Quartz
 - Converted to a printer's color space
 - **Some printers don't register profiles**
 - Sent by driver to an ink-jet printer



A ColorSync Chain—Weak Links

- Apps using QuickTime Graphics Importers must explicitly check for embedded profiles

```
OSErr ConvertToTiff (const FSSpec *from, const FSSpec *into)
{
    OSErr          err=noErr;
    Handle         prof=nil;
    unsigned long  size=0;
    ComponentInstance  imp=0, exp=0;

    // Get a graphics importer for the given file.
    err = GetGraphicsImporterForFile(from, &imp);
    // Open an exporter of type TIFF.
    err = OpenADefaultComponent('grip', 'TIFF', &exp);

    // Tell the exporter to copy from importer to file
    err = GraphicsExportSetInputGraphicsImporter(exp, imp);
    err = GraphicsExportSetOutputFile(exp, into);
}
```



A ColorSync Chain—Weak Links

- Apps using QuickTime Graphics Importers must explicitly check for embedded profiles

```
// Copy the profile
```

```
err = GraphicsImportGetColorSyncProfile(imp, &prof);
```

```
if (prof)
```

```
    err = GraphicsExportSetColorSyncProfile(exp, prof);
```

```
// Do the export.
```

```
err = GraphicsExportDoExport(exp, &size);
```

```
// Clean-up.
```

```
if (exp) CloseComponent(exp);
```

```
if (imp) CloseComponent(imp);
```

```
if (prof) DisposeHandle(prof);
```

```
return err;
```

```
}
```



A ColorSync Chain—Weak Links

- Conversion for Printing
- Quartz matches all color data, tagged or untagged, to printer's registered profile
- If printer does not register a profile then the Quartz matches data to the display profile
 - All data will be sent to the driver in a common space but that space will vary from one Mac to another
- Some drivers may choose to do additional color conversion after receiving the data from Quartz





ColorSync Jaguar Update

ColorSync Jaguar Update

- Profiles
- Framework
- Preference Pane
- Utility



ColorSync Jaguar Update

- Updated Profiles
 - Generic RGB Profile
 - Was: \approx P22 phosphors, 9300°K, 1.8 gamma
 - Now: P22 phosphors, D65, 1.8 gamma
 - Generic CMYK Profile
 - Was: Based on the Apple Color LaserWriter
 - Now: Based on sub-sampled TR001 SWOP profile



ColorSync Jaguar Update

- Framework
 - Device Integration Notifications
 - kCMDeviceRegisteredNotification
 - kCMDeviceUnregisteredNotification
 - kCMDefaultDeviceNotification
 - kCMDeviceProfilesNotification
 - kCMDefaultDeviceProfileNotification
 - ColorSync Preferences Notifications
 - kCMPrefsChangedNotification



ColorSync Jaguar Update

- Example: How to have your app be notified when the display profile changes

```
- (void) register
{
    center = [NSDistributedNotificationCenter defaultCenter];

    [center addObserver:self selector:@selector(notification:)
                name:(NSString*)kCMDeviceUnregisteredNotification object:nil];

    [center addObserver:self selector:@selector(notification:)
                name:(NSString*)kCMDefaultDeviceNotification object:nil];

    [center addObserver:self selector:@selector(notification:)
                name:(NSString*)kCMDeviceProfilesNotification object:nil];

    [center addObserver:self selector:@selector(notification:)
                name:(NSString*)kCMDefaultDeviceProfileNotification object:nil];
}

- (void) notification:(NSNotification*)n
{
    CMGetDefaultProfileByUse(cmDisplayUse, &gDispProf);
}
```



ColorSync Jaguar Update

- ColorSync Preferences Pane
 - Removed Devices tab
 - Removed Workflow
 - Enhanced Tooltips



ColorSync Jaguar Update

- Utility
 - Profile First Aid
 - ColorSync Devices Browser
 - Profile Inspector





Demo

ColorSync Utility



ColorSync and Quartz

Quartz Color Management

- Objective
 - Integrated graphics and color management
- Requirements
 - Composite different color spaces and opacity
 - Scalable color management solution
 - Color accuracy
 - Performance
 - PDF compatibility



Quartz Color Management

Quartz Color
Data

+

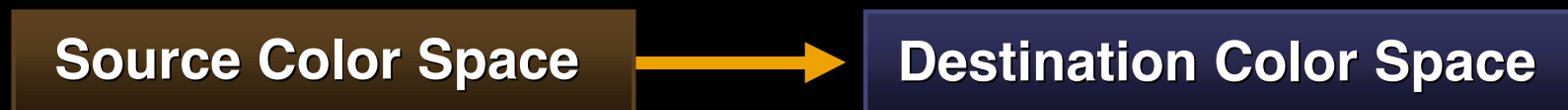
ColorSync
Engine



PDF Color Model

- PDF color definition
 - /DeviceGray, /DeviceRGB, /DeviceCMYK
 - /CalGray, /CalRGB, /CalLab
 - /ICCBased
- PDF color conversions

Function (source, destination, rendering intent)

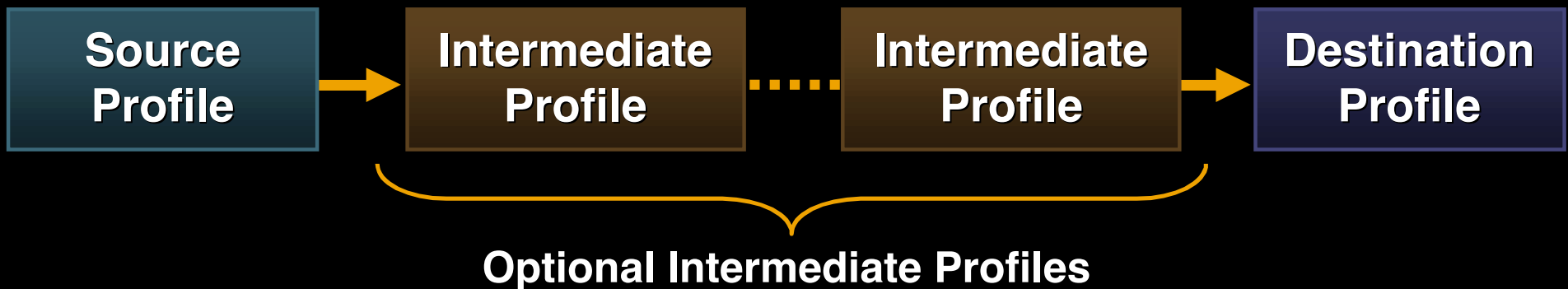


Rendering intent = {perceptual, relative colorimetric, saturation, absolute colorimetric}

ColorSync/ICC Color Model

- ICC color definition
 - ICC profile
- ICC color conversions

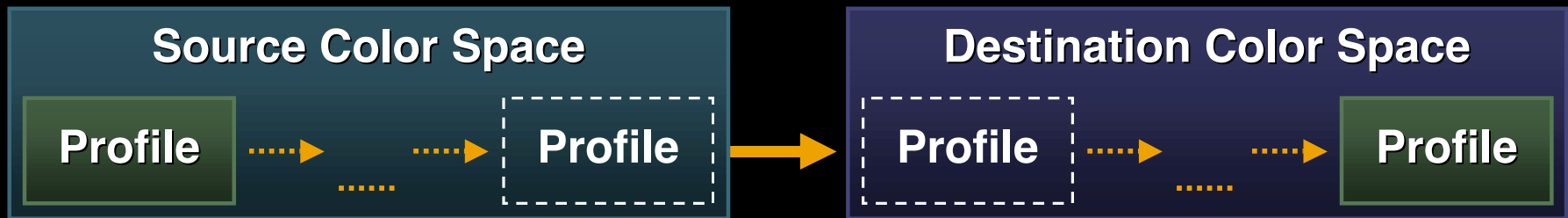
Function ($\sum_{i=2}^n$ Profiles (rendering intent))



Rendering intent = {perceptual, relative colorimetric, saturation, absolute colorimetric}

Color Model in Quartz

- Color space is one or more ICC profiles



- Preserve PDF concept of matching source to destination
- Suitable for advanced color management like softproofing, special effects, color device simulation, etc.
- Can be concatenated by ColorSync to a single ICC profile



Color Model in Quartz

- Device color spaces assigned default profiles

/DeviceGray → Quartz Default Gray

/DeviceRGB → Quartz Default RGB

/DeviceCMYK → Quartz Default CMYK

- PDF /CalGray, /CalRGB, /CalLab → ICC profiles



Color Model in Quartz

- Special color spaces for drawing to the screen

Display RGB

=

System Profile

Display Gray

=

Gray to RGB



System Profile



Color Model in Quartz

- Special color spaces for user preferred profiles

User Default Gray = **ColorSync Default Gray profile for documents**

User Default RGB = **ColorSync Default RGB profile for documents**

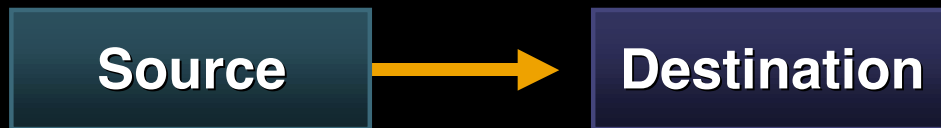
User Default CMYK = **ColorSync Default CMYK profile for documents**



Color Model in Quartz

- Color space equivalence

If (source color space == destination color space)
{
 no conversion is required – data remains unaltered
}



}
else

{

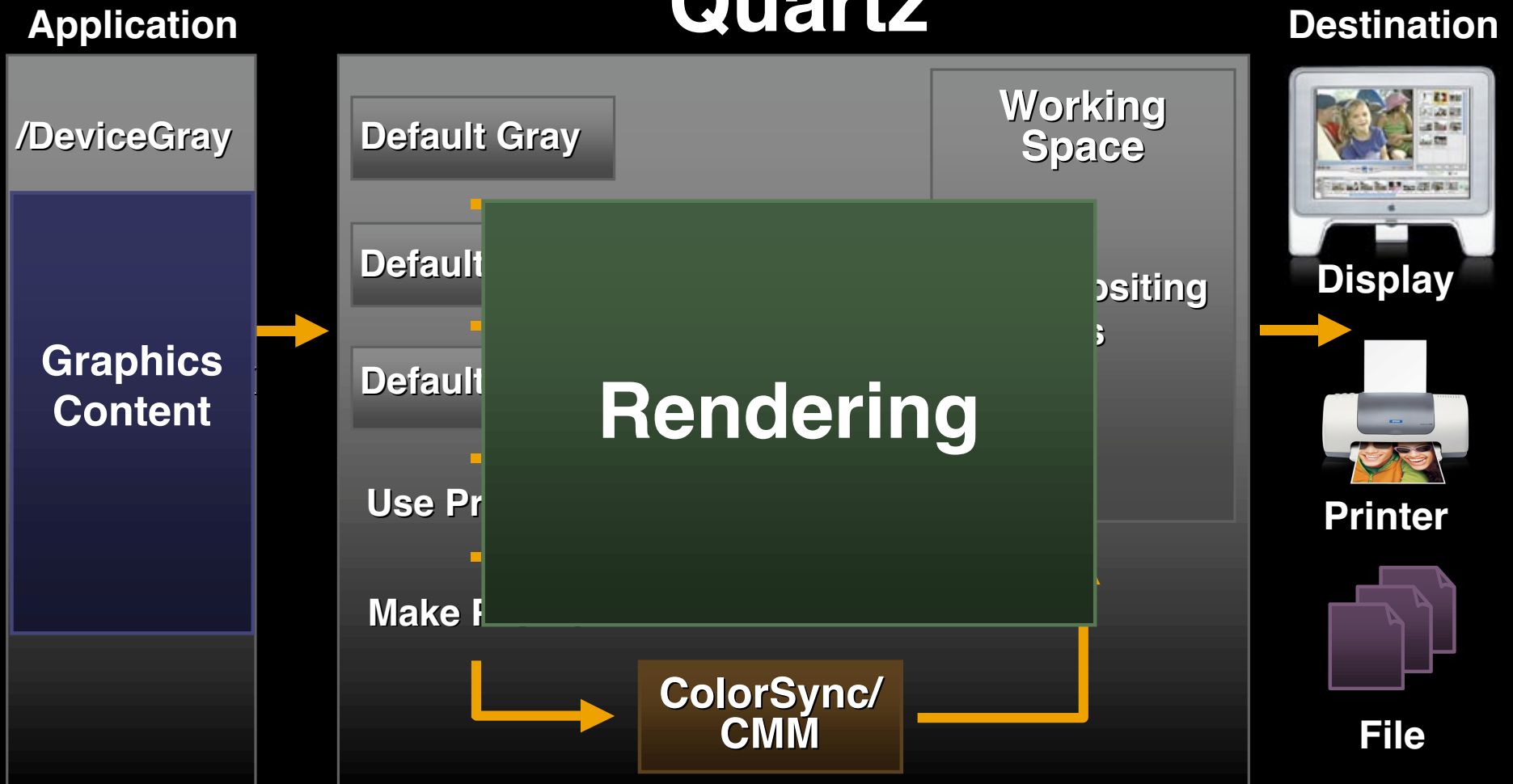


}



Color in Quartz Drawing Model

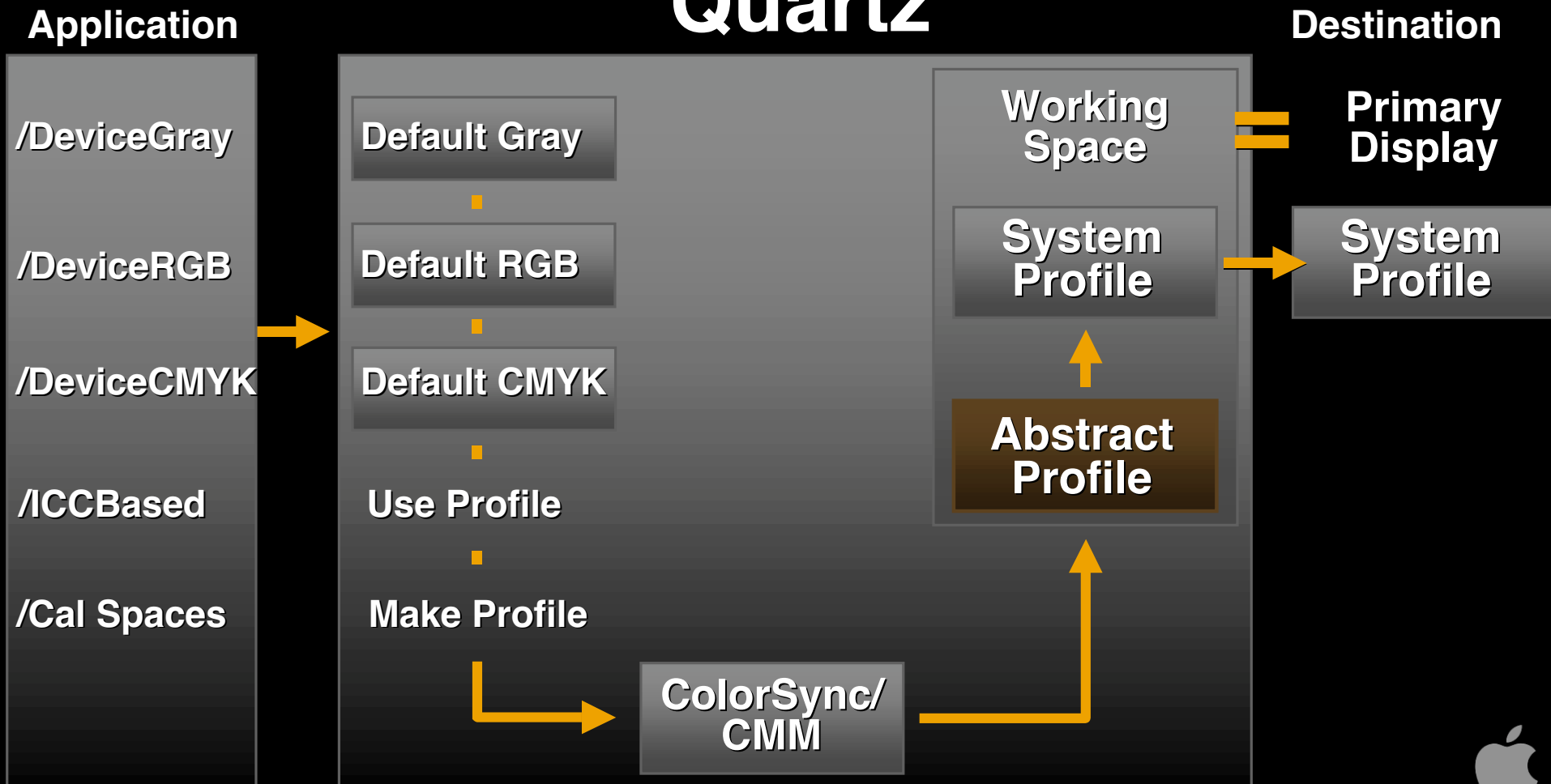
Quartz



Color in Quartz Drawing Model

Applying Special Effects Abstract Profile

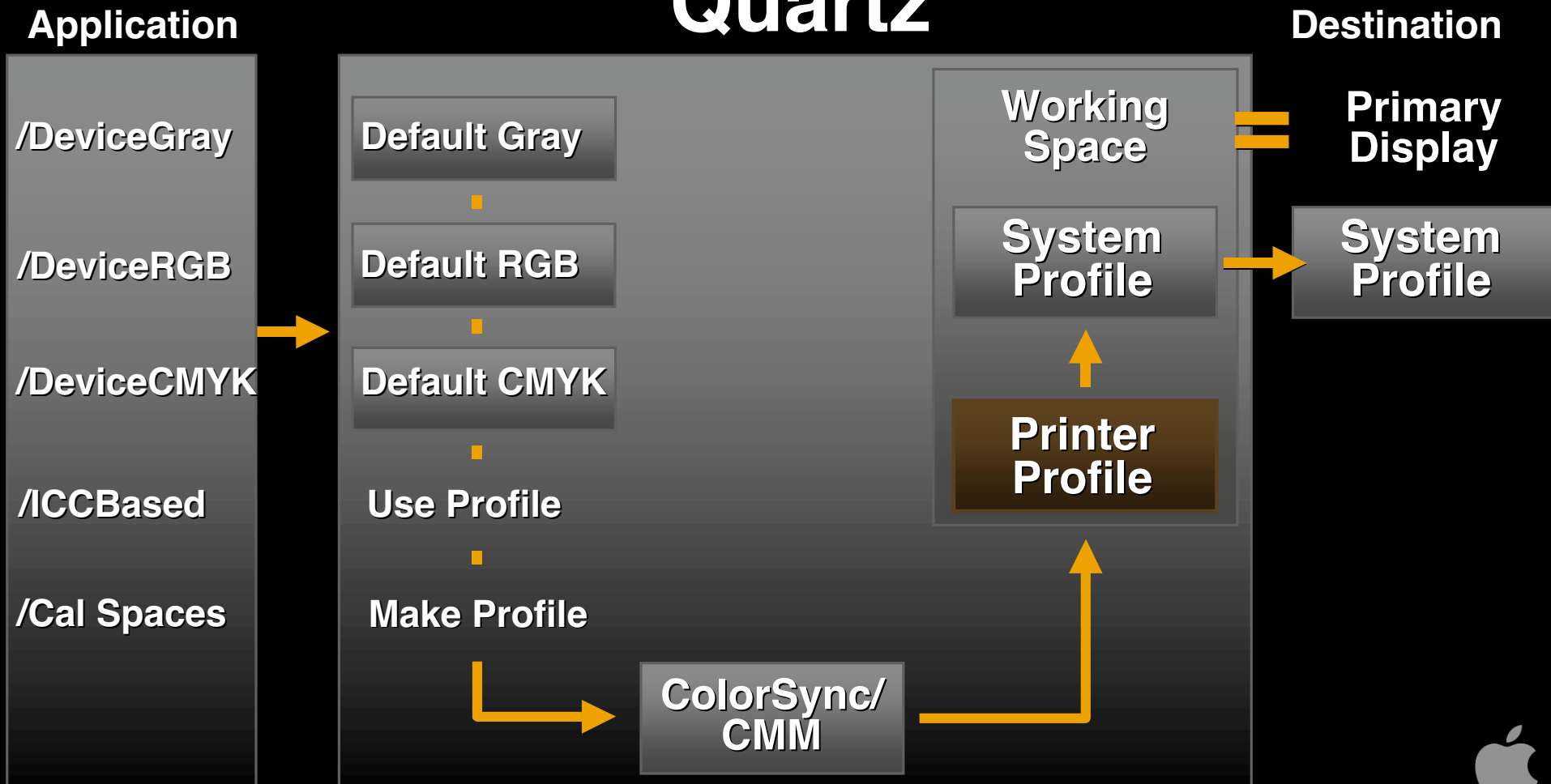
Quartz



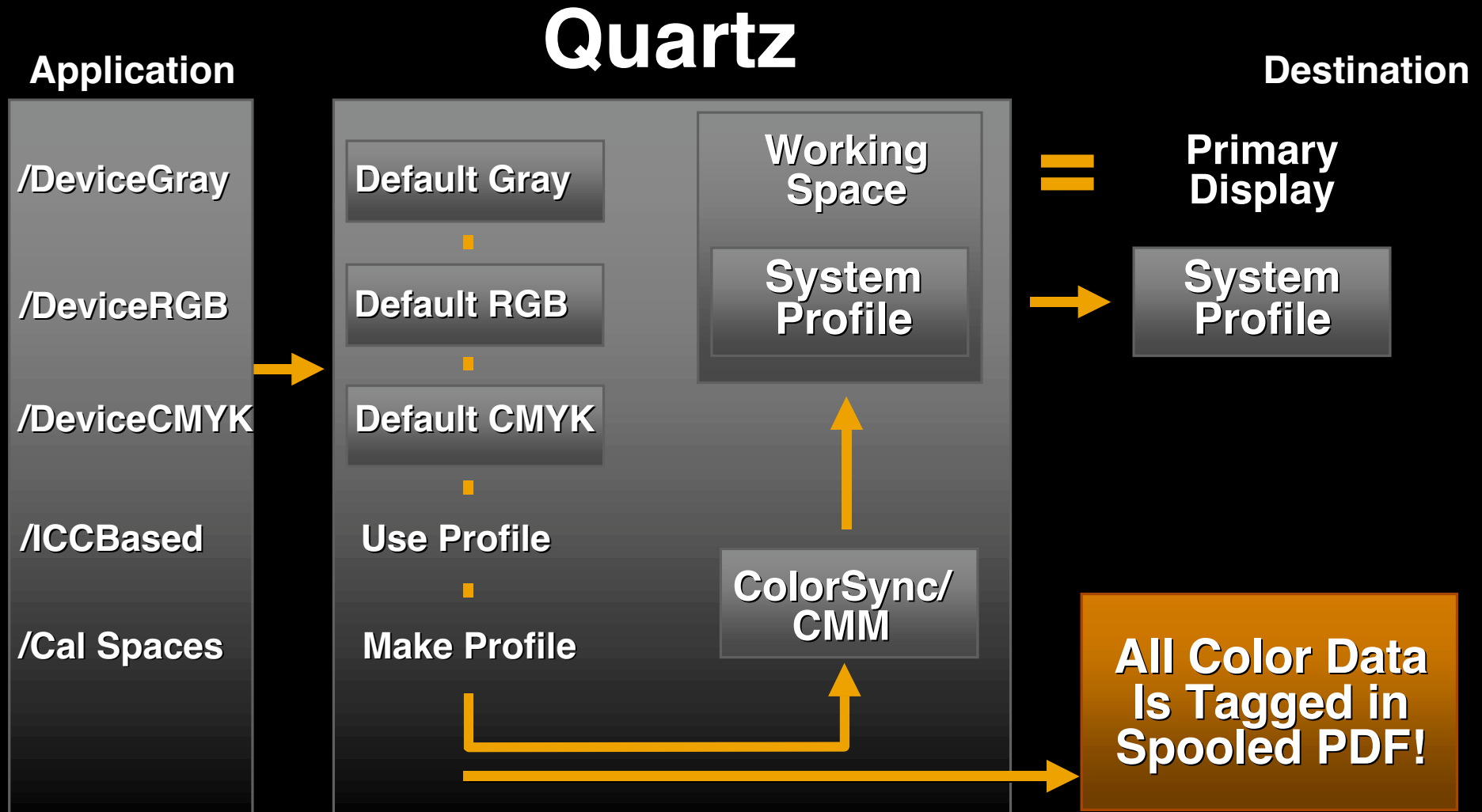
Color in Quartz Drawing Model

Softproofing Printout on Primary Display

Quartz



Color in Printing From Quartz





ColorSync and Video

ColorSync and Video

- Traditional ColorSync color management
 - Conversion from source to destination profiles
- Traditional video color correction
 - Turning knobs to achieve a desired visual effects



ColorSync and Video

- These two models can be combined into one ColorSync workflow using:
 - Assigned source or embedded profile
 - One or more abstract profiles to achieve desired visual effects
 - Destination profile



ColorSync and Video

- Advantages of using a ColorSync workflow
 - Abstract profiles operate in the perceptually uniform Lab color space
 - Abstract profiles can be archived as a standard ICC profile for future use
 - Destination can be changed later
 - Destination can be a device profile or the profile for a standard color space



ColorSync and Video

- How does it perform?
 - Software-only solution give performance adequate for basic preview or offline processing
 - But using OpenGL to leverage video-card hardware gives real-time performance



ColorSync and Video

- ColorSync in Real-time
 - Makes use of the per-pixel 3D texture-map hardware available on the video card
 - nVidia GeForce4 Ti card, etc . . .
 - Uses ColorSync, OpenGL, QuickTime, Quartz
 - Play QuickTime content
 - On a Quartz OpenGL surface
 - With a 3D texture built from a ColorSync CWorldRef





Demo

ColorSync and Video

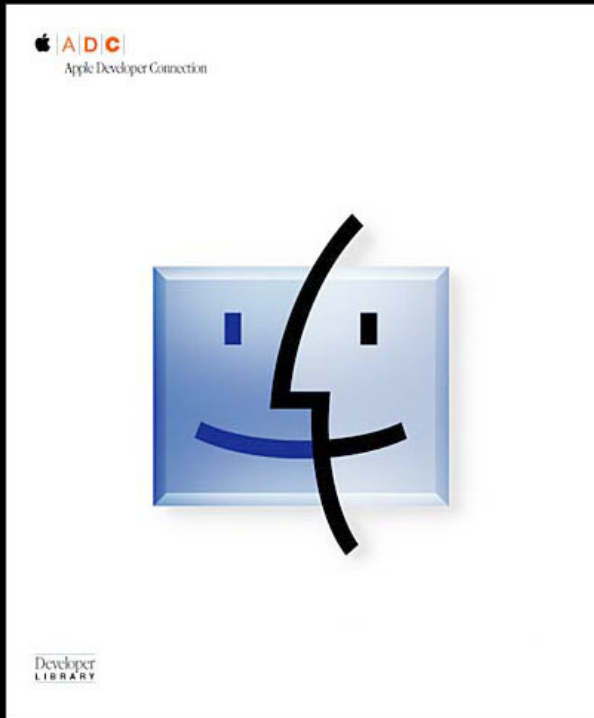
For More Information

- [**www.apple.com/colorsenc**](http://www.apple.com/colorsenc)
- [**www.apple.com/developer/sdk/**](http://www.apple.com/developer/sdk/)
- colorsenc-dev and colorsenc-users lists
- [**colorsenc@apple.com**](mailto:colorsenc@apple.com)



Documentation

ColorSync



- Managing Color With ColorSync
- ColorSync Reference

Documentation > Carbon > Graphics > ColorSync Manager

developer.apple.com/techpubs/macosx/Carbon/graphics/ColorSyncManager/colorsyncmanager.html



More Documentation

ColorSync

- TN 2035:
ColorSync on Mac OS X
- TN 1185:
New ColorSync 3.0 APIs
- TN 1160:
What's New With ColorSync 2.6

developer.apple.com/technotes/indexes/color-a.html



Roadmap

500 Graphics and Imaging Overview

Room A2
Tue., 10:30am

501 Quartz 2D and PDF

Room A2
Tue., 2:00pm

503 Exploring the Quartz Compositor

Hall 2
Tue., 3:30pm

**504 OpenGL:
Graphics Programmability**

Room A2
Tue., 5:00pm



Roadmap

505 OpenGL: Integrated Graphics I

Room J
Wed., 9:00am

506 OpenGL: Integrated Graphics II

Room J
Wed., 10:30am

109 Darwin Printing

Room J
Wed., 2:00pm

509 ColorSync and Digital Media

Room C
Wed., 5:00pm



Roadmap

510 Printing and Mac OS X

Hall 2
Thurs., 10:30am

513 OpenGL: Advanced 3D

Room J
Thurs., 3:30pm

**514 OpenGL:
Performance and Optimization**

Room J
Thurs., 5:00pm

515 Image Capture Framework

Room C
Fri., 2:00pm



Roadmap

**516 Graphics and Imaging
Performance Tuning**

Hall 2
Fri., 3:30pm

FF 018 Graphics and Imaging

Room J1
Fri., 5:00pm



Who to Contact

Travis Brown

Graphics and Imaging Evangelist

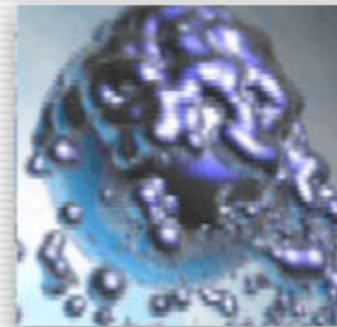
Travis@apple.com

<http://developer.apple.com/wwdc2002/urls.html>





Q&A



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Graphics and Imaging Evangelist
Worldwide Developer Relations

<http://developer.apple.com/wwdc2002/urls.html>

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